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Prepared for

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EVALUATION OF SOURCES OF ODOR POLLUTION IN AN AREA OF KANSAS CITY, MISSOURI

U.S.Environmental Protection Agency, Region VII
1735 Baltimore
Kansas City, Missouri 64108

1974

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EVALUATION OF SOURCES OF ODOR POLLUTION IN AN AREA OF KANSAS CITY, MISSOURI

FINAL REPORT

EPA Contract No. 68-01-0453

MRI Project No. 3701-C

For

Environmental Protection Agency, Region VII
1735 Baltimore Avenue
Kansas City, Missouri 64108

Attn: Mr. Dewayne E. Durst

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EVALUATION OF SOURCES OF ODOR POLLUTION IN AN AREA OF KANSAS CITY, MISSOURI

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ABSTRACT

This report presents an evaluation of potential odor sources in an area of Kansas City, Missouri.

The evaluation was accomplished by collecting background and source samples to obtain a "fingerprint" for each potential odor source. The source "fingerprints" were then compared with five odor complaint "fingerprints" to determine the odor source. The probable source was identified as Chemagro Corporation in two odor episodes, American Oil Company in one odor episode, and a combination of Conservation Chemical Company and Chemagro Corporation in two odor episodes. There was an indication that the Kansas City, Missouri, Big Blue Treatment Plant was making a minor contribution in one odor sample, and no indication that the Independence, Missouri, Sewage Plant was involved in any of the odor complaints.

ACKNOWLEDGMENTS

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Messrs. C. C. Potter, George H. DeLapp and Larry J. Cole of the Air Quality Division of the City of Kansas City, Missouri, and Dr. John N. Goulias of the Missouri Air Conservation Commission provided assistance in coordinating the program.

Approved for:

MIDWEST RESEARCH INSTITUTE

H. M. Hubbard, Director
Physical Sciences Division

7 February 1974

SUMMARY

Episodes involving unpleasant odors have occurred in recent years in the northeast section of Kansas City, Missouri, and its neighboring areas of Sugar Creek and Independence, Missouri. This report presents an evaluation of five potential odor sources which were believed to be contributing to many of the odor episodes.

The five sources evaluated were selected because they have a high potential as contributors to the odor problem. Up-and downwind samples were collected to determine volatiles contributed to the airshed by each source.

The collected volatiles were separated by means of gas-liquid chromatography with flame-ionization detection. A preliminary screening indicated that the best separation could be obtained by SF-96 and FFAP columns. The relative retention times of the components were used to "fingerprint" and compare the volatiles contained in each sample. The components which were specific to each source were then compared to the components in a sample collected during an odor episode.

From the comparison of "fingerprints," it appears that the odor complaint sampled on 1 January 1973 contained effluent primarily from the American Oil Corporation. The odor complaint sampled on 26 February 1973 contained effluent from four sources; the major contributors were identified as Chemagro Corporation and the Conservation Chemical Company. The odor complaints sampled on the 1st and 16th of March 1973 contained primarily effluent from Chemagro Corporation. Effluents from Chemagro Corporation and Conservation Chemical Company were the primary contributors to the odor complaint sampled on 3 July 1973. A minor contribution resulted from the effluent from American Oil Corporation.

INTRODUCTION

The Northeast section of Kansas City, Missouri, and its neighboring areas of Sugar Creek and Independence, Missouri, contain a number of industries utilizing or processing odorous materials. Numerous odor complaints have been filed with cognizant regulatory agencies in recent years. Because it is almost impossible to discriminate between odorous materials of a similar chemical nature, or to identify different sources of the same odorous compound by olfactory methods, the control of odor pollution has been extremely difficult. Source identification is further complicated by the highly subjective odor response of persons making or investigating complaints.

In an effort to assist the various government agencies responsible for odor control, the Environmental Protection Agency awarded Midwest Research Institute (MRI) a contract to apply its odor "finerprint" method to the source-identification problem. Five potential odor sources were selected for study in the program. The five sources evaluated were selected because they have a high potential as contributors to the odor problem.

In the following sections of this report, we present a discussion of the program organization meeting, the MRI "fingerprint" method, source-sampling activities conducted during the program, odor-sampling activities, methodology of analyses of odor samples, results of analysis of samples, and conclusions of the comparisons of odor complaints and source fingerprints.

PROGRAM ORGANIZATION MEETING

A meeting was held on 29 September 1972 to discuss the organization and scope of the program. Those in attendance were Messrs. Dewayne Durst and John Giar from EPA; Mickey Marshal from the Missouri Air Conservation Commission; Carl C. Potter and Larry J. Cole from the Air Quality Division of the City of Kansas City, Missouri; and A. E. Vandegrift and Fred Bergman from MRI. After a discussion of the possible odor sources in the study area, the following sources and sampling requirements were selected: Conservation Chemical Company (three samples); Kansas City, Missouri, Big Blue Sludge Incinerator (three samples); American Oil Company (three samples); Independence Sewage Treatment Plant (two samples); Chemagro Corporation (three or more samples). Upwind (background) samples were also to be collected as required at each potential source.

The sampling series chosen consisted of five background samples in the residential area, and 10 odor samples collected when confirmed odor episodes were in progress.

MRI "FINGERPRINT" METHOD

The MRI "fingerprint" method of odor sampling consists of three main steps:

1) Collecting a concentrated sample of the volatile components present in the atmosphere during an odor episode;

2) Collecting samples of volatile components in the air up- and downwind of each potential odor source; and

3) Separating the components in each sample by gas-liquid chromatography (GLC).

The relative retention time of each component found in the odor sample is compared with the relative retention times of the components from the source samples. A match between components in the odor sample and a suspected source indicates that the effluent from the suspected source was in the area undergoing an odor episode. After the source has been identified, other techniques are employed to confirm the component match.

Several methods are available for collecting the volatiles dispersed in the atmosphere. The method employed by MRI throughout this program was cryogenic trapping. Cryogenic trapping involves drawing an atmospheric sample by a vacuum pump: first through a drying tube containing silica gel, and then through a trap immersed in liquid nitrogen. The trap consists of a high-pressure, stainless steel, "U-" shaped trap with stainless steel valves at each end. The trap is filled with Chrom P Reg. 30/60 mesh chromatographic support to improve the trapping efficiency. The sampling system and trap construction are shown in Figure 1. The filled trap has a volumetric capacity of 50 ml. After 100 to 200 liters of sample air have been drawn through the trap, the liquid oxygen and methane are vacuum-distilled from the trap. Distillation is accomplished while the trap is held at liquid nitrogen temperature. The valves are then closed, and the trap is removed from the liquid nitrogen and returned to the laboratory for analysis.

The traps as received from the field contain only a small amount of material, and therefore quantitative recovery of the sample from the trap is required prior to analysis. To accomplish this recovery, the contents of the trap

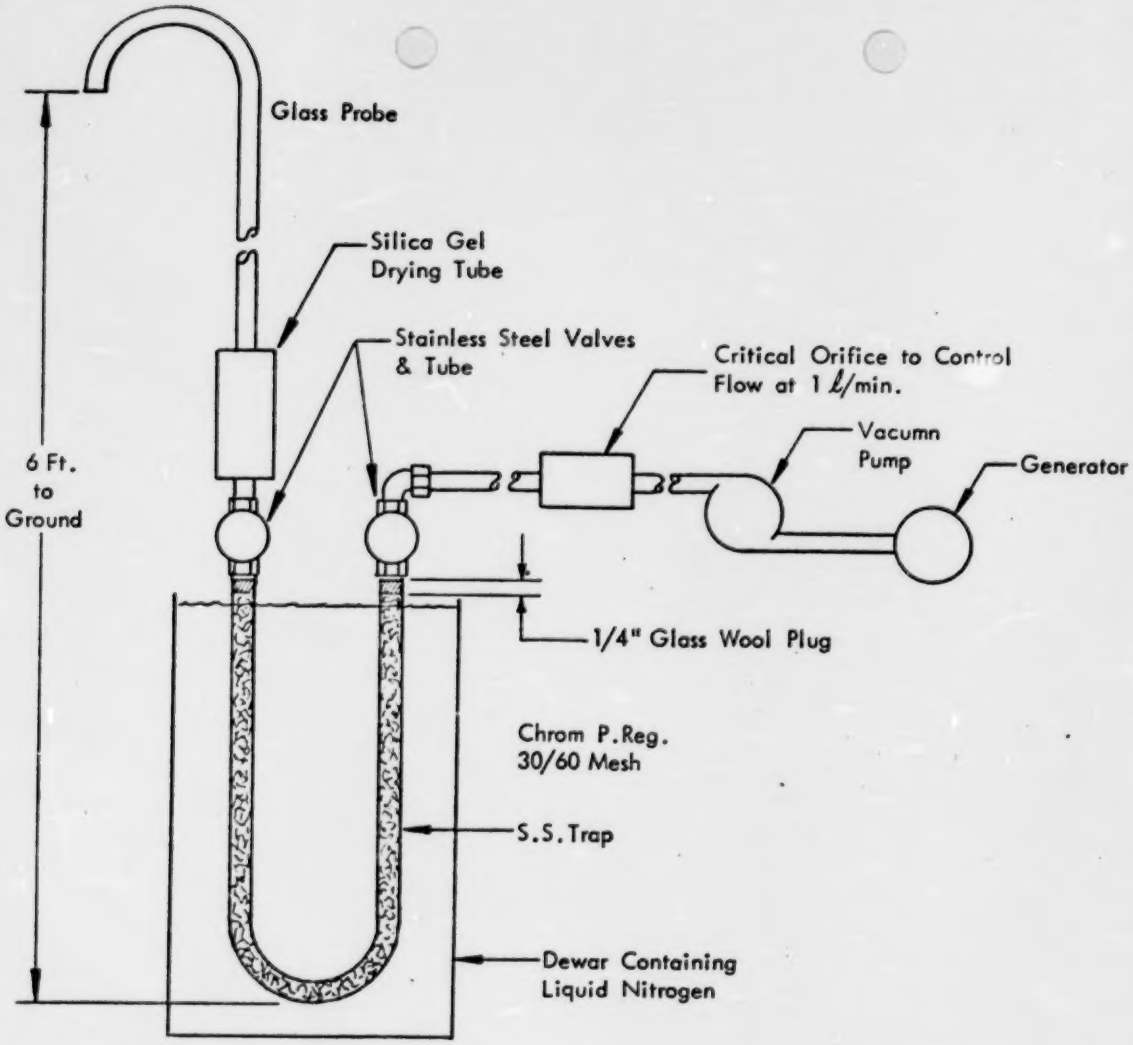

Figure 1 - Sampling System

are vacuum-distilled, with mild heating, into a glass receiver containing 0.5 ml of spectrograde carbon disulfide.

The samples are transferred to carbon disulfide to facilitate handling and to permit the injection of a larger sample to the GLC column than could be accomplished if the sample were handled in the vapor form. The use of a solvent also permits storage of the remainder of the sample for further evaluation. Carbon disulfide was selected because it produces no response using flame-ionization detection (FID), and will not mask any of the sample components.

After the distillation is completed, the receiver is warmed until the carbon disulfide melts (-108.6°C), and is shaken, and the contents are transferred from the receiver to a glass vial equipped with a septum cap. A 4-µl sample is removed through the septum with a syringe for injection onto the GLC column. Between analyses the glass vial is stored at -15°C.

The first analytical operations performed after the samples are collected is a rapid screening of various column materials to determine which column packing produces the best component resolution. The optimum GLC columns selected are then used to separate the components contained in each source and odor sample. Chromatographic conditions are maintained as nearly the same as possible during all subsequent analyses.

Although various methods of detection can be utilized with the GLC separation, flame-ionization detection was selected for its high sensitivity (2×10^{-11} to 9×10^{-13} g).

SOURCE-SAMPLING ACTIVITIES

Following the procedure described in the preceding section, source and source background samples were collected as described in Table I. The first series of source samples (No. 1-14) were collected prior to receiving any confirmed odor complaints. Samples 19 and 20 were collected after four odor samples had been collected; 22 through 27 were collected after the fifth odor sample.

The sampling sites were selected so that the background sample was always upwind of the potential source. The source-sample site was always downwind and directly opposite the background sample site, with the source lying directly between. The sampling day was selected on the basis of wind direction so that samples would not contain the "signature" of other sources being investigated. To prevent saturating the drying tube attached to the trap, sampling was restricted to periods without precipitation. The samples were held in the stainless steel trap until just prior to analysis.

Table I. SUMMARY OF SOURCE-SAMPLING ACTIVITY

Sample No.	Trap No.	Source	Date	Sampling Data				
				Start	Stop	Time (min)	Sample Type	Wind Direction
1	XVII	American Oil	11/10/72	10:02 a.m.	3:55 p.m.	353	Source	East
2	XVIII	American Oil	11/10/72	10:57 a.m.	4:13 p.m.	316	Background	East
3	XIX	Chemagro	11/20/72	10:19 a.m.	3:00 p.m.	281	Background	East
4	XX	Chemagro	11/20/72	10:35 a.m.	3:05 p.m.	270	Source	East
5	XXI	Chemagro	11/21/72	10:00 a.m.	3:57 p.m.	357	Source	North
6	XXII	Chemagro	11/21/72	10:40 a.m.	3:46 p.m.	306	Background	North
7	XV	K.C. Blue	11/27/72	9:45 a.m.	3:45 p.m.	360	Source	North Northeast
8	VI	K.C. Blue	11/27/72	10:05 a.m.	3:55 p.m.	350	Background	North Northeast
9	XIV	Independence Sewage	11/28/72	9:55 a.m.	3:55 p.m.	360	Source	Northeast
10	VII	Independence Sewage	11/28/72	10:10 a.m.	4:00 p.m.	350	Background	Northeast
11	III	Chemagro	11/29/72	9:45 a.m.	3:40 p.m.	355	Source	Northeast
12	IV	Chemagro	11/29/72	9:55 a.m.	3:46 p.m.	351	Background	Northeast
13	VIII	American Oil	11/30/72	9:50 a.m.	3:40 p.m.	350	Source	Northeast
14	XIII	Independence Sewage	11/30/72	10:05 a.m.	3:50 p.m.	345	Source	North
19	II	Conservation Chemical	3/29/73	11:00 a.m.	2:32 p.m.	212	Source	East Northeast
20	XXV	Conservation Chemical	3/29/73	9:55 a.m.	1:27 p.m.	152	Background	East Northeast
22	VII (2)	Conservation Chemical	11/1/73	10:35 a.m.	4:35 p.m.	360	Source	South
23	XXIV	Chemagro	11/1/73	3:15 p.m.	5:25 p.m.	130	Source	South Southwest

Table I. (Concluded)

Sample No.	Trap No.	Source	Date	Sampling Data				
				Start	Stop	Time (min)	Sample Type	Wind Direction
24	XX (2)	K.C. Blue	11/2/73	10:55 a.m.	5:05 p.m.	370	Source	North
25	XXV (2)	Conservation Chemical	11/2/73	11:30 a.m.	6:20 p.m.	410	Source	Northwest North
26	XVIII (2)	K.C. Blue	11/5/73	11:25 a.m.	5:40 p.m.	375	Source	Northwest North
27	VIII (2)	American Oil	11/5/73	1:00 p.m.	6:25 p.m.	325	Source	Northeast North Northeast

ODOR-SAMPLING ACTIVITIES

Odor samples were collected on the basis of odor complaints. When several odor complaints were received by the Kansas City, Missouri, Air Quality Division, MRI was notified and a city field inspector was dispatched to evaluate the odor. If the existence of an odor episode was not confirmed by the inspector, the city would cancel the alert. If the existence of an odor was confirmed, the field inspector would wait for the MRI crew to arrive in the field.

A copy of a typical field inspector's report is reproduced in Figure 2.

After MRI was alerted, the field-sampling crew filled the liquid-nitrogen containers and drove to the odor site. If the odor was still present when the field-sampling crew arrived, they set up the sampling system and started sampling at the complaint location.

To complete the odor sample, a second sample was collected at the same location at a later date to serve as a background for the odor sample. Each odor background sample was collected during a period when objectionable odors were absent. A description of the odor sampling and corresponding background samples is given in Table II.

Odor complaints which were received and not samples, and the reason for not sampling, are shown in Table III.

KANSAS CITY AIR POLLUTION CONTROL
Scentometer Reading

Alleged Source Chemagro

Address 8400 Hauser Rd.

Date 12-28-73

Time	Reading	Location From Source
5:15 p.m.	7:1 Dilution	558 So Agland
5:20 p.m.	7:1 Dilution	" " "
5:30 p.m.	No Reading	117 So Ag.

Wind Speed 12 mph

Wind Direction NW

INSPECTOR [signature]

MRI NOTIFIED 1650 HRS
BY PHONE VIA P.W. DISP.

Figure 2 - Field Inspector's Report

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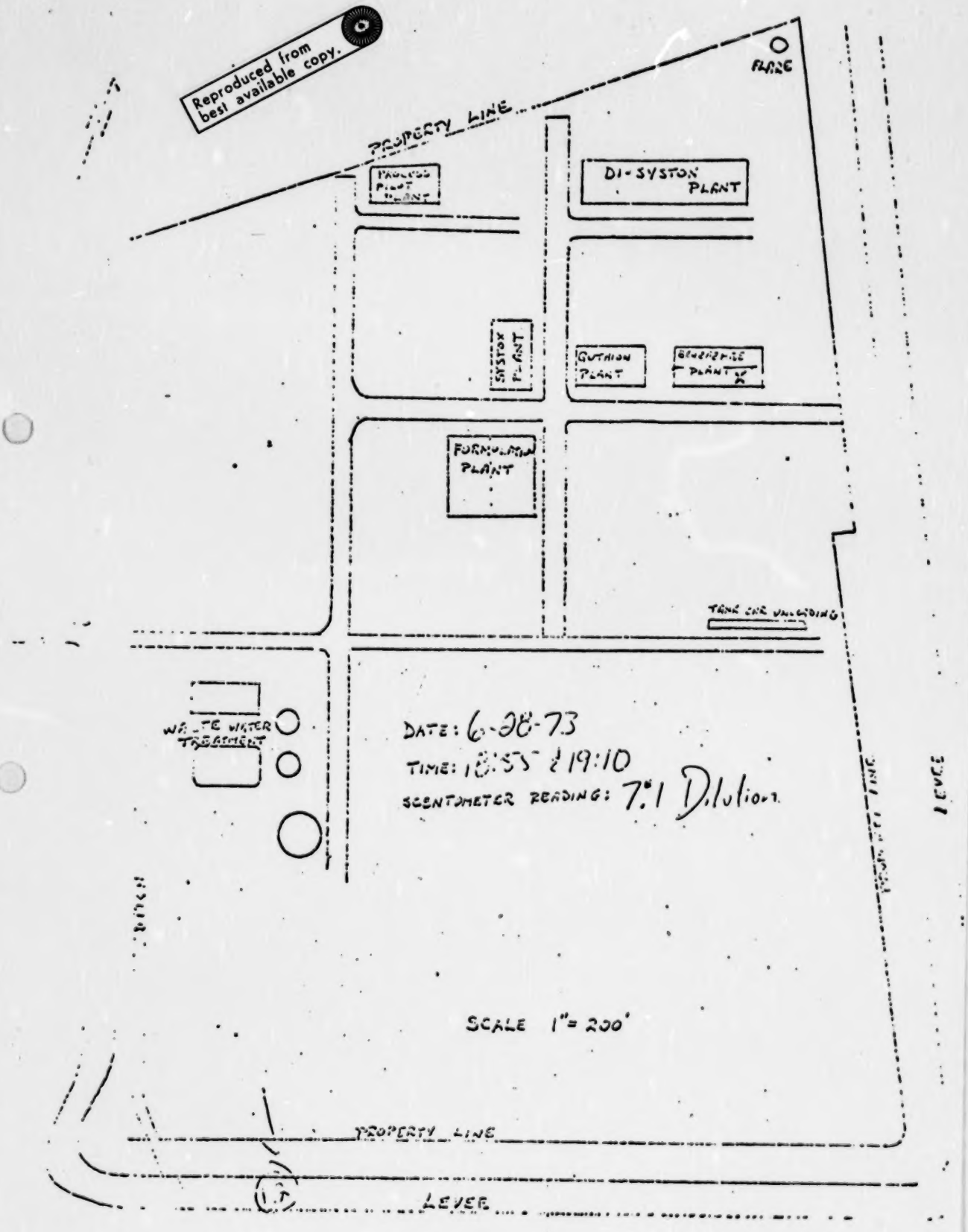

Table II. ODOR SAMPLING

Sample No.	Trap No.	Sampling Location	Sampling Date	Start	Stop	Time (min)	Wind Direction	Average Wind Velocity (mph)	
15	0	10100 Truman Road Independence, Missouri	1/26/73	2:20 p.m.	4:20 p.m.	120	North	10	Overcast-mild No precipitation
16	I	Smalley and Winner Road, Kansas City Missouri	2/26/73	1:08 p.m.	2:11 p.m.	63	Northeast	9	No precipitation
17	XI	Dead End Front Street and I-435, Kansas City, Missouri	3/1/73	3:38 p.m.	5:38 p.m.	120	East	12	No precipitation
18	XXIV	118 S. Ash, Independence, Missouri	3/16/73	5:18 p.m.	7:18 p.m.	120	Northwest	14	No precipitation
21	IX	1132 Bellmont, Kansas City, Missouri	7/3/73	12:10 p.m.	12:55 p.m.	45	Northeast	11	No precipitation Wind shifted during sampling and odor disappeared
15A	XVII(2)	10100 Truman Road	2/26/73	1:30	2:45	75	Northeast	8-9	Background for No. 15
16A	XIX(2)	Smalley and Winner Road	3/1/73	4:00	6:00	120	East	12	Background for No. 16
17A	XXI(2)	Dead End Front Street	3/16/73	6:15	8:00	105	Northwest	14	Background for No. 17
18A	XXII(2)	118 S. Ash	7/3/73	3:00	4:00	60	Northeast	11	Background for No. 18
21A	XV(2)	1140 Bellmont	11/1/73	10:00	12:00	120	South Southwest	10	Background for No. 21

Table III. ODOR COMPLAINTS NOT SAMPLED

Date	Time	Address	Reason Not Sampled
2/2/73	1:00 p.m.	116 S. Ash	Odor dissipated
2/7/73		2227 Popular	Not confirmed
4/3/73		Independence, Missouri	No personnel available
4/10/73		Independence, Missouri	No personnel available
5/[illegible]/73		Independence, Missouri	Not confirmed
5/11/73	5:00 p.m.	809 S. Brookside	No personnel available before odor dissipated
5/18/73		Independence, Missouri	Not confirmed
5/25/73		Independence, Missouri	Not confirmed
6/1/73		Independence, Missouri	Not confirmed
6/8/73		Independence, Missouri	Not confirmed
6/[illegible]8/73	5:10 p.m.	Arlington and Kentucky	Odor dissipated
7/11/73	9:45 a.m.	Independence, Missouri	Odor dissipated
8/1/73	1:00 a.m.	809 S. Brookside	No personnel available before odor dissipated
8/13/73		Blue Ridge Boulevard and 40 Highway	No personnel available

METHODOLOGY OF SAMPLE ANALYSIS

Selection of the best GLC column is a necessary initial step in the analysis of samples because the components of the samples are of such a diversified nature that it is virtually impossible to predict which GLC columns will give optimum separation. Potential columns were screened by injection of samples onto the column and determination of which performed the best. All the columns used were 1/8 in. x 2 m. The columns screened were FFAP, SF-96, Squalane, Carbowax 20 M and 400, Apiezon L, OV-17, SE-30, β,β oxydipropriononitrile, and Poropac Q. The best separation of sample components was obtained on FFAP and SF-96. The SF-96 packing was 20% on 60/80 mesh acid-washed Chromosorb P, and the FFAP was 10% on Chromosorb W, 60/80 mesh.

Sample analysis was performed by a Perkin-Elmer Mark II gas chromatograph equipped with temperature programming and flame-ionization detection. Helium was used as the carrier gas at a flow rate of 20 cc/min. The FFAP column was operated for 2 min at 65°C and temperature-programmed at 5°/min to 210°C. The SF-96 column was operated for 2 min at 35°C and temperature-programmed at 5°/min to 150°C. These conditions were determined to be near optimum during the column-selection phase of the program. Runs made while selecting columns were programmed to the temperature limit of the packing. This procedure established that complete elution of all the significant components in the sample was being obtained at the temperatures used.

Each sample (source, odor and background) was run with both the SF-96 and FFAP columns being used. A typical chromatogram is shown in Figure 3. The number of peaks (components) obtained from the samples are summarized in Table IV.

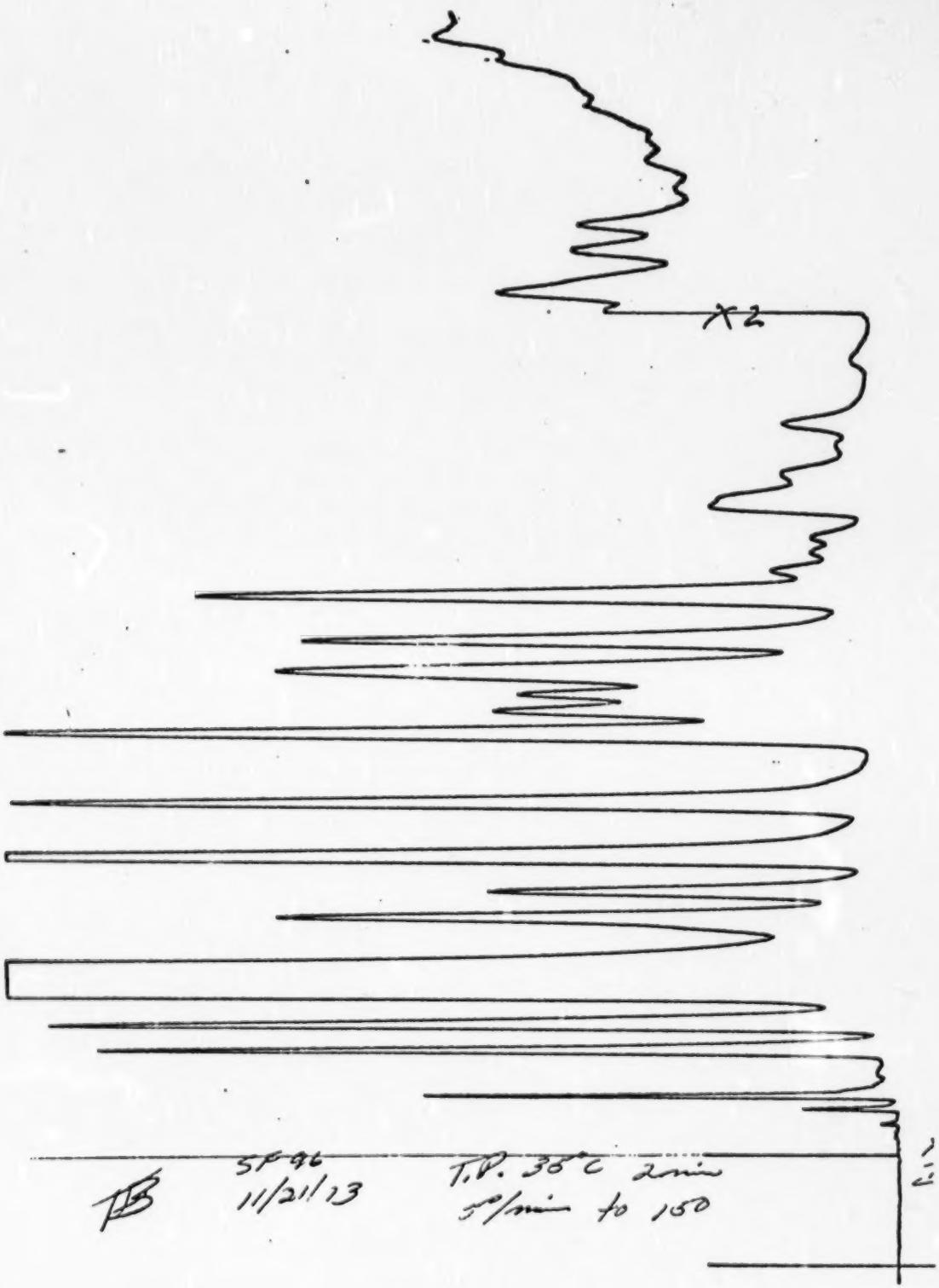

Figure 3 - Typical Chromatogram

Table IV. NUMBER OF COMPONENTS IN SAMPLE

Column	SF-96	FFAP
Source background	13-31	20-32
Odor background	8-26	9-28
American Oil Corporation	16-19	28-32
Chemagro Corporation	28-32	30-36
Conservation Chemical Company	16-24	25-27
Kansas City, Missouri Big Blue Treatment Plant	24-30	21-23
Independence, Missouri Sewage Plant	13-15	20-28
Odor	18-20	14-17

RESULTS OF SAMPLE ANALYSIS

The relative retention time* of each component was used as the means of "fingerprinting" individual odor sources. The use of relative retention times partially corrects for variation in column operating conditions. The relative retention times (i.e., components) in each source sample were compared with the relative retention times (i.e., components) in the source background. Those components found in the source sample and not in the background represent the "fingerprint" or "signature" of the source. The results of the source-background comparison from the FFAP column are shown in Table V. The source-background comparison using SF-96 is shown in Table VI.

The same procedure was used with the odor samples. In this case the source-sample components were compared with the background sample collected at the same location when odors were not present.

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* Relative retention time is the time required for a component to be eluted from th column divided by the time required for an internal standard to be eluted.

Table V. SOURCE SIGNATURE
(Relative Retention Time-FFAP[a/])

America Oil Corporation Sample No.			Chemagro Corporation Sample No.				Conservation Chemical Company Sample No.			Kansas City, Missouri Big Blue Plant Sample No.			Independence, Missouri Sewage Treatment Sample No.	
1	2	3	1	2	3	4	1	2	3	1	2	3	1	2
										[b/]				19
										23				
			39							39				
			44			44								
							48	48	48			48		
				53										
							61	61	61					
66														
			69											
				73										
							77	77	77					
				87										
								90						
	107	107												
							111	111	111					
117	117													
	120	120												
								125						
			183											
			188											
			195		195									
198														
					205									

a/ Relative retention time is the time required for a component to be eluted from the column divided by the time required for an internal standard to be eluted.

b/ None over background

Table VI. SOURCE SIGNATURE
(Relative Retention Time-SF-96[a/])

American Oil Corporation Sample No.			Chemagro Corporation Sample No.				Conservation Chemical Company Sample No.			Kansas City, Missouri Big Blue Plant Sample No.			Independence Missouri Sewage Treatment Sample No.	
1	2	3	1	2	3	4	1	2	3	1	2	3	1	2
				9							b/			
				13										
				24									24	24
				28										
	41	41												
				54										54
					81	81								
87														
	88	88												
									92					
					94	94								
								101						
									105					
			112	112				112						
								123						
			131	131					131					
138				138			138							
								143						
							146							
					150									
														164
					167									
								171						
							203							
			211											
	215													

a/ Relative retention time is the time required for a component to be eluted from the column divided by the time required for an internal standard to be eluted.

b/ None over background

FINGERPRINT COMPARISONS

Tables VII and VIII present an odor comparison or odor "fingerprint" for the odor complaints samples in this program. The first five columns in Table VII present comparisons for samples analyzed with the FFAP column, while Table VIII presents comparisons using the SF-96 column.

In both Tables VII and VIII, an "X" was placed in the source columns if a component was found in the source sample which agreed in relative retention time with one occurring in an odor sample. The number of "X's" corresponds with the frequency that the component was found in the source samples. The "X's" are underlined when the component was specific to one source.

The relative retention time of two different components can be almost identical. Therefore the use of relative retention time without further evaluation could lead to erroneous assumptions. Additional proof that the odor "fingerprint" components were the same as those identified in the source samples was obtained by chromatographing a composite sample. An aliquot of an odor sample and a source sample containing what appeared to be the same component was mixed and analyzed. If the component was the same in both samples, a single peak would be observed at the normal retention time. If the components were not identical, two peaks side-by-side or the development of a shoulder on the peak being examined would occur. This comparison technique was applied to all odor/source samples containing components with matching relative retention times. In the few cases where the odor/source components were not identical, the components were eliminated from the evaluation.

A source is identified as a contributor of effluent in the odor episode by weighing the match obtained between an odor sample and a source sample components. In determining the potential source for odor sample No. 1, our comparison shows component 66 matches with American Oil Corporation (see Table VII). This component was found specifically in one of three source samples from American Oil Corporation. Components 107 and 120 (Table VII) also match with American Oil Corporation, and were found to be

Table VIII. COMPARISON OF SOURCE SIGNATURES WITH ODOR SIGNATURES

Relative Retention Time - SF-96

Odor Sample No.					American Oil Corporation	Chemagro Corporation	Conservation Chemical	Kansas City Big Blue	Independence, Missouri Sewage
1	2	3	4	5					
		9				X			
		13		13		X			
		24		24		X			XX
		28	28	28		X			
41					XX				
		54		54		X			X
	81	81		81		XX			
88					XX				
		92		92			X		
	94	94		94		XX			
			101				X		
	105							X	
112	112	112				XX	X		
	123						X		
	131		131			XX		X	
	146						X		
		150	150			X			
	164	164		164		X			X
				203			X		
			211			X			
	215				X				

Table VII. COMPARISON OF SOURCE SIGNATURES WITH ODOR SIGNATURES

Relative Retention Time - FFAP

Odor Sample Number					American Oil Corporation	Chemagro Company	Conservation Chemical Company	Kansas City, Missouri Big Blue	Independence, Missouri Sewage
1	2	3	4	5					
		39	39	39		X		X	
		44	44	44		XX			
				48			XXX	X	
	58	58	58						
		61	61	61			XXX		
66					X				
	69			69		X			
		73	73			X			
	77		77	77			XXX		
		81							
			87			X			
90				90			X		
98									
		102							
107				107	XX				
111							XXX		
	117				XX				
120				120	XX				
	136								
			145						
				146					
				158					
				166					
				175					
			205			X			

specific in two of the three samples. Component 90 matches with Conservation Chemical Corporation, and was found to be specific in one of three samples (Table VII). Component 111 also matches with Conservation Chemical and was found specifically in three of three samples (Table VII). American Oil Corporation and Conservation Chemical Company are clearly potential sources for odor complaint sample No. 1.

Odor sample No. 2, using FFAP (Table VII) shows a component at 58 and 136 which does not match any of the source "fingerprints." Component 69 matches with one sample specifically from Chemagro Corporation. Component 77 matches specifically with three out of three samples from Conservation Chemical Company. Component 117 matches specifically with two out of three samples from American Oil Corporation. The "fingerprints" indicate that American Oil Corporation, Chemagro Corporation and Conservation Chemical Company were contributors to odor sample No. 2.

Odor sample No. 3 shows a component at 39 which was found in one source sample from both Chemagro Corporation and the Kansas City, Missouri, Big Blue Treatment Plant (Table VII). Component 44 was specific to Chemagro Corporation in two out of three samples. Component 61 was specific and found in all samples from Conservation Chemical Company. Component 73 was specific to Chemagro Corporation and found in one sample. Components 58, 81, and 102 were not found in any of the source samples. This fact would indicate that odor sample No. 3 contains effluent from Chemagro Corporation, Conservation Chemical Company, and Kansas,City, Missouri, Big Blue Treatment Plant. The fit was best between the odor fingerprint and Chemagro Corporation. Conservation Chemical Company and the Big Blue Treatment Plant showed some matching components.

Odor sample No. 4 also contained components 39, 44, 58, 61, and 73 (Table VII). These components were found in the fingerprints of Chemagro Corporation, Kansas City, Missouri, Big Blue Treatment Plant, and Conservation Chemical Company. A component at 77 was noted for the first time which was specifically in all three samples from Conservation Chemical Company. Component 87 was specific to Chemagro Corporation. Component 145 was not found in any source sample, while component 205 was specific to Chemagro Corporation. Chemagro Corporation, Big Blue Treatment Plant, and Conservation Chemical Company all contributed to odor sample No. 4.

Odor sample No. 5 again shows components 39, 44, and 61 (Table VII). Component 48 was found in the fingerprints of both Conservation Chemical Corporation and the Big Blue Treatment Plant. Component 69 was specific in one sample for Chemagro Corporation. Component 77 was specific and found in all samples from Conservation Chemical Corporation. Components

107 and 120 were specific and found in two samples from American Oil. Components 146, 158, 166, and 175 were not found in any of the source samples. We find a strong match with Chemagro Corporation and Conservation Chemical, and a weaker match with American Oil and the Big Blue Treatment Plant for odor sample No. 5.

The same comparisons were made using SF-96 as shown in Table VIII. Odor sample No. 1 shows components at 41 and 88 which match specifically with American Oil. The component at 112 matches with Chemagro Corporation and Conservation Chemical Company. This comparison provides a strong indication that American Oil, with a possible contribution by Chemagro Corporation and Conservation Chemical Company, accounted for odor sample No. 1.

Odor sample No. 2 contains components at 81 and 94 which match with components specific to Chemagro Corporation (Table VIII). Component 105 matches specifically with the Big Blue Treatment Plant, and component 112 matches with Chemagro Corporation and Conservation Chemical Company. Component 123 was specific to Conservation Chemical Company and component 131 was found at Chemagro Corporation and the Big Blue Treatment Plant. Component 146 was specific to Conservation Chemical Corporation. Component 164 was found at both Chemagro Corporation and the Independence, Missouri, Sewage Plant. Component 215 was specific to the American Oil Corporation. It appears that any or all sources examined could have contributed to odor sample No. 2.

Odor sample No. 3 contains components at 9, 13, 28, 81, 94, and 150 which were specific to Chemagro Corporation (Table VIII). It also contained components at 24, 54, and 164 which could be from either Chemagro Corporation or the Independence, Missouri, Sewage Plant. Component 92 was specific to Conservation Chemical Corporation, and component 112 could be from either Chemagro Corporation or Conservation Chemical Company. There is a strong indication that the main source was Chemagro Corporation, with a single component potential from Conservation Chemical Corporation.

Odor sample No. 4 contained components 28, 150, and 211, a specific match with Chemagro Corporation (Table VIII). It also contained 131 indicating either Chemagro Corporation or the Big Blue Treatment Plant. The remaining component 101 gave a specific match with Conservation Chemical. It appears that the probable source of odor sample No. 4 was Chemagro Corporation.

Odor sample No. 5 contained components 13, 28, 81, and 94 which are specific to Chemagro Corporation (Table VIII). Components 54 and 164 could be either Chemagro Corporation or the Independence, Missouri, Sewage Plant. Component

92 and 203 were specific to Conservation Chemical Company. We conclude that odor sample No. 5 contained effluent primarily from Chemagro Corporation with a contribution from Conservation Chemical Company/

To assist in evaluating the "fingerprint" comparisons, it is helpful to examine the prevailing wind direction. Sources which were downwind from the odor complaint area could not be considered sources. To assist in this evaluation, the source location and odor sampling sites were marked on the map shown in Figure 4. The legend for the locations is given in Table IX. Weather conditions were recorded during sampling. The wind direction recorded during the program is compared with results obtained from the records of the National Weather Service in Table X. The wind directions agree on 26 February 1973, and 16 March 1973. On the other 3 days the recorded data do not agree with the official data.

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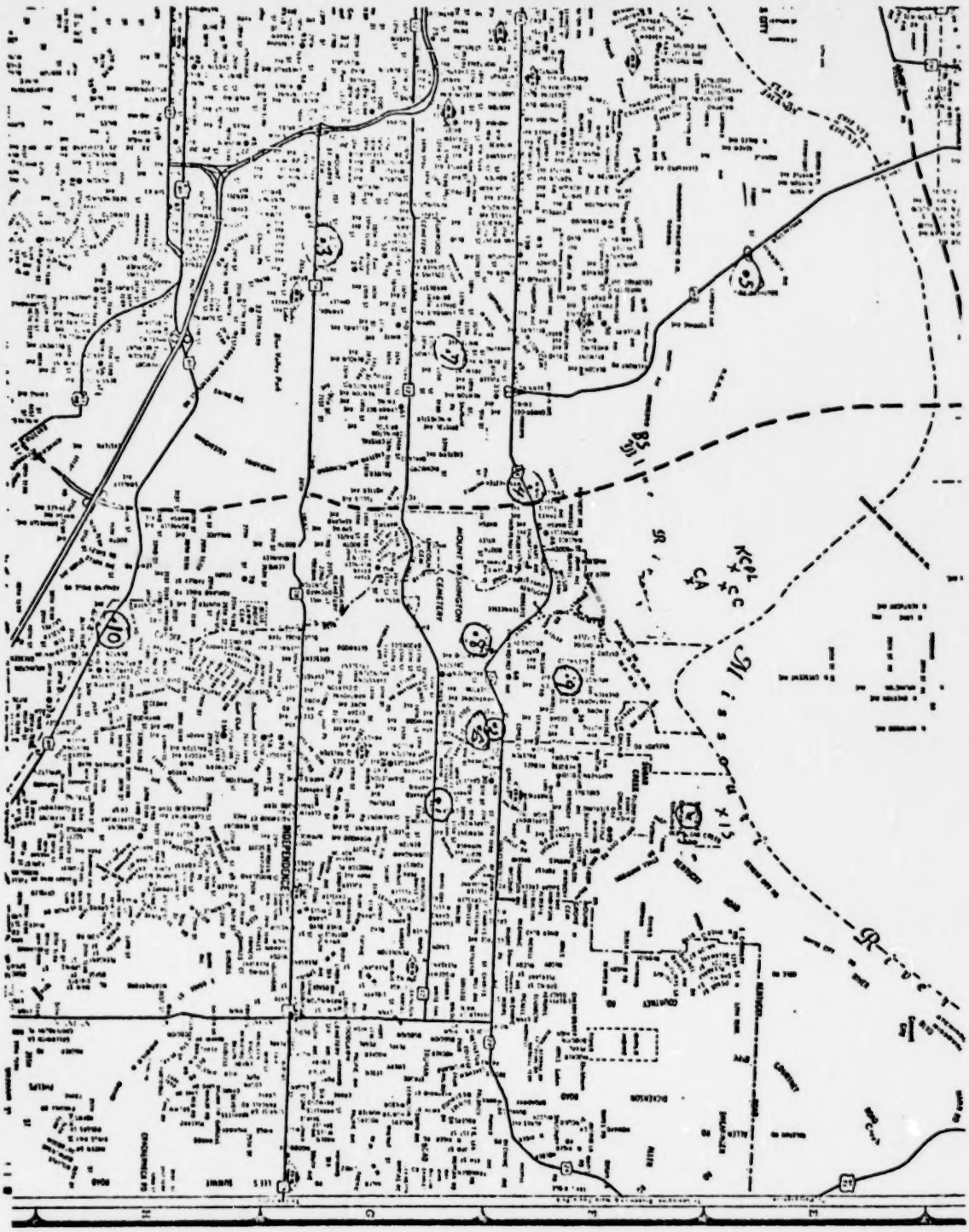

Figure 4 - Source and Sampling Locations

Table IX. LOCATION DESIGNATION

XIS	=	Independence, Missouri Sewage Plant
XAD	=	American Oil Corporation
XKCPL	=	Kansas City Power and Light Plant
XCC	=	Conservational Chemical Company
CA	=	Chemagro Corporation
BS	=	Kansas City, Missouri Big Blue Treatment Plant
1	=	Sample No. 15, 10100 Truman Road
2	=	Odor Complaint not sampled, 116 S. Ash
3	=	Odor Complaint not sampled, 2227 Popular
4	=	Sample No. 16, Smalley and Winner Road
5	=	Sample No. 17, Dead End Front Street and I-435
6	=	Sample No. 18, 118 S. Ash
7	=	Sample No. 21, 1132 Bellmont
8	=	Odor Complaint not sampled, 809 S. Brookside
9	=	Odor Complaint not sampled, Arlington and Kentucky
10	=	Odor Complaint not sampled, Blue Ridge Boulevard and 40 Hiway

Table X. WEATHER ON SAMPLING DAYS

Date	From National Weather Service	Wind Direction Recorded at Site
1/26/73	Wind 9.9 mph average; 14 maximum No precipitation; direction-Southwest	North
2/26/73	Wind 8.5 mph average; 9 mph maximum No precipitation; direction-Northeast	Northeast
3/1/73	Wind 12.2 mph average; 22 mph maximum No precipitation; direction-Southwest	East
3/16/73	Wind 14.4 mph average; 22 mph maximum No precipitation; direction-Northwest	Northwest
7/3/73	Wind 10.6 mph average; 22 mph maximum No precipitation; direction-Southeast	Northeast

CONCLUSIONS FROM FINGERPRINT COMPARISONS

A compilation of the FFAP and SF-96 data interpretation is presented in Table XI. When an odor component was specific to a single source, a letter "A" was inserted in the corresponding source block. When an odor component was found in the fingerprint of two or more sources, a letter "B" was placed in each corresponding source. In those samples where a "B" occurred without a reinforcing "A," the "B" was rejected and the component assigned to a stronger source, by drawing a line through the rejected "B."

It is our understanding that Conservation Chemical Company processes waste from American Oil Corporation. This fact may explain why we found components from both sources in several samples when conditions were not favorable. If this relationship between American Oil Corporation and Conservation Chemical Company is considered valid, the results from the program are fairly specific.

For odor sample No. 1 collected at 10100 Truman Road, Independence, Missouri, on 26 January 1973, American Oil Corporation was the primary contributor of the effluent found in the area. There was a minor indication that Conservation Chemical Company might have contributed but the wind direction on that day makes this unlikely.

The odor sample No. 2 collected at Smalley and Winner Road, Kansas City, Missouri, on 26 February 1973, appears to consist primarily of effluent from Chemagro Corporation and Conservation Chemical Company. There was a slight indication that the Kansas City, Missouri, Big Blue Treatment Plant and American Oil Corporation might be contributing.

The odor sample No. 3 collected at the dead end of Front Street near I-435 in Kansas City, Missouri, on 1 March 1973, was primarily from Chemagro Corporation, with a possible slight contribution by Conservation Chemical Company.

Table XI. SUMMARY OF ODOR FINGERPRINT COMPARISONS

Odor Sample No.	1 (1)	2 (4)	3 (5)	4 (6)	5 (7)
American Oil Corporation	AAA AA	AA			AA
Chemagro Corporation	B	AAABB	BAA AAAAAA 3B B	5B AA AAA B	3B A AAAA 2B
Conservation Chemical Company	AA B	A BAA B	AAB	5B AA	3B BAA AA
Kansas City, Missouri Blue Treatment Plant		A B	B	5B B	3B, B
Independence, Missouri Sewage Plant		B	3B		2B
Wind Direction	AO, IS	CC, CA, AO, IS	CC, CA, IS, AO	CC, CA, BS	CC, CABS AO, IS
Summary	AO (CC)	CA, CC, (BS) (AO)	CA (CC)	CA (CC)	CA, CC (AO)

The odor sample collected at 118 South Ash, Independence, Missouri, on 16 March 1973, was primarily from Chemagro Corporation with a possible slight contribution by Conservation Chemical Company.

The odor sample collected at 1132 Bellmont, Kansas City, Missouri, on 3 July 1973, was primarily from Chemagro Corporation and Conservation Chemical Company with a possible slight contribution by American Oil Corporation.

In general, it appears that the effluent found in the odor complaint area was primarily from American Oil Corporation on 26 January 1973, Chemagro Corporation and Conservation Chemical Company on 26 February and 3 July 1973, and Chemagro Corporation on 1 and 16 March 1973. It should be pointed out that the technique used during this program identifies plant effluent and not the odorous constituents. The technique established the probable sources for the odor without determining which component or components are directly responsible for the problem.

To assist other investigators interested in expanding this investigation, the Retention Index (I_S) of a select number of the sample components was determined. Norman paraffins were injected with the samples to establish fixed points. From the values obtained, the retention indices were calculated for a number of the components, and are reported in Table XII.

Table XII. RETENTION INDICES

SF-96

Source	Component Relative Retention Time	I_s
Kansas City Big Blue	105	692
Chemagro	131	731
Conservation Chemical	146	769
Chemagro	150	775
Chemagro and Independence Sewage	164	801
Conservation Chemical	171	817
Conservation Chemical	203	890
Chemagro	211	918
Background Components		
	190	872
	195	880
	198	889
	207	895
	245	978
	251	988

FFAP

Source	Component Relative Retention Time	I_s
Chemagro	54	1,038
Chemagro	61	1,065
Chemagro	73	1,114
Chemagro	87	1,164
American Oil	107	1,226
Conservation Chemical	125	1,288
Chemagro	183	1,479
	188	1,494
	195	1,520